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THE MAYA LUNAR COUNT[1]

By Dr. CARL E. GUTHE

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MY subject concerns certain aspects of the indigenous calendar of the Maya Indians of Middle America. This time count consisted of named days and months associated with short number series which, in principle, is closely similar to our own calendar. The dates thus obtained, analogous to our term "Tuesday, the 29th of December," were located, during the earlier period of their civilization, in a count of days from an hypothecated starting point in a manner identical to the system used by European astronomers when they compute in terms of "Julian days." Because of this "Long Count" the many dates recorded in stone during the earlier period are accurate to within a day with relation to one another. For further details concerning the mechanics of this calendar, I refer you to a number of publications.[2]

An outline of the history of the remarkable Maya civilization has been obtained in terms of this native calendar. Because of the influence which this group of people exerted both directly and indirectly upon the majority of the indigenous civilizations of the New World it is of great importance that the Maya calendar be expressed in terms of the European calendar. The problem is to determine the numerical con-

[1] Address of the vice-president and chairman of Section H—Anthropology, American Association for the Advancement of Science, New Orleans, December 29, 1931.

[2] S. G. Morley, "An Introduction to the Study of the Maya Hieroglyphs," Bureau of American Ethnology, Washington, Bulletin 57, 1915; H. J. Spinden, "The Reduction of Mayan Dates," Papers of the Peabody Museum of American Archeology and Ethnology, Harvard University, Vol. vi, No. 4, 1924; J. E. Teeple, "Maya Astronomy," Carnegie Institution of Washington; Contributions to American Archeology, No. 2, Publication 403, pp. 29–115, 1930.

stant which must be added to the Long Count to obtain the equivalent Julian Day.

Offhand, the obvious suggestion is to search early Spanish records for a statement of a date in both calendars. Unfortunately, the Mayas had abandoned the use of the Long Count before the Spaniards encountered them. Such dates as are given in both calendars give only the Maya cyclic dates, which repeat themselves at regular intervals in the Long Count. The interpretations of these data offered by specialists give several different values for the constant to which I have referred, the two most acceptable ones differing from one another by nearly 260 years. This situation has given rise to what is technically known as the "Correlation Problem."

Since the post-contact records are inconclusive in themselves, it is necessary to seek additional data in the more ancient inscriptions in which the Long Count is recorded. The only phenomena which were surely observed by both the Maya Indians and the Europeans prior to the sixteenth century were astronomical. Hence such Maya records as appear to be of this character have undergone a severe scrutiny. The technical problems involved excited my interest, and have caused me to review at least some of the indigenous records referring to the moon.

The problem before us is such that two specific questions concerning the Maya records of the moon are of particular importance. The first of these is, "What phase of the moon was used as the beginning of the Maya lunar month?" and the second "Did the Mayas, during the period of the inscriptions, use a computed calendar which approximated the periodicity of lunations, or did they record the beginning of the lunar month from direct observation?" These are the two questions I lay before you.

The first of these may be studied from several viewpoints, namely, customs of similar civilizations, the European-Maya records, and the indigenous native records. A survey of lunar calendars over the world discloses that while a majority of them contain months beginning at the new moon phase, several use the full moon phase for this purpose. Since both customs do exist we must dismiss this line of attack as failing to yield conclusive data.

As far as I know now, the only definite statement on this subject yet found in the early Spanish records is made by Bishop Landa, the first Bishop of Yucatan, when he states that the Mayas counted from the time the new moon rises till it disappears. Certain statements made by the Bishop on a number of subjects have been either accepted or proved as correct. At first sight, then, this would appear to be good evidence. A further consideration reveals that some of Landa's statements are incorrect. Moreover, all the Spanish records are subject to the criticism that they record the interpretation of a native civilization by a group of persons tending to be unsympathetic towards non-European customs, influenced by European habits, and untrained in obtaining accurate ethnological records. Dr. Ludendorff suggests that this record of the new moon as the beginning of the lunar month may be the result of a leading question on Landa's part, which is possible.[3] Therefore, with all due consideration for Landa's mental honesty and acumen, which is so clearly illustrated in his work, we must conclude that while this evidence is more probably correct than false, we can not consider it as conclusive.

European records of associated and later times should also be considered. Dr. Willson has written, "the fact is known that the ancient Mexicans did not make use of lunar eclipses,"[4] but does not give his source for the statement. Of course lunar eclipses can only occur at time of full moon. Dr. Willson used solar eclipses in his work, which meant that he supported the use of the new moon as the beginning of the lunar month. It is probable that his statement is based upon early Spanish sources from Mexico, which may be more definite, but to which the additional objection may be raised that they concern a different, even though closely related, civilization. In short, the evidence from other European records is also not definitive.

There remain the data from the native records, *i.e.*, the inscriptions and the manuscripts. The only apparent clue to this problem in the inscriptions was suggested by Mr. J. E. Thompson in the course of a conversation during the past month, and embodied in a letter to me from which I quote: "The lunar glyphs themselves might be construed as possible evidence of the Maya lunar count of the inscriptions having started from new and not full moon.

"Glyph C represents a completed moon, but the lunar element of this glyph is of crescentic shape. If the lunar month was completed at new moon one would expect the moon to be shown as crescentic, but if the moon was completed at full moon, one would expect Glyph C to show a full moon. Such is not the case. Similarly, if the moon count starts at new moon, one would expect Glyph D to be represented by a new moon; but if the lunar month starts at full moon, one would expect the full moon element to occur in Glyph D. Actually it is shown as cres-

[3] H. Ludendorff, "Das Mondalter in den Inschriften der Maya," Sitzungsberichten der Preussischen Akademie der Wissenschaften, Phys.-Math. Klasse, 1931, iii.

[4] R. W. Willson, "Astronomical Notes on the Maya Codices," Papers of the Peabody Museum of American Archeology and Ethnology, Harvard University, Vol. vi, No. 3, 1924.

crescentic. Glyph E, following the Maya vigesimal count, represents twenty days after the start of the lunar month. If this is counted from new moon, Glyph E should be a full moon, since at 20 days after new moon, the moon is considerably closer to full than to crescentic. If the count was from full moon, Glyph E, on the same line of argument, should be shown as crescentic. Actually it is shown as full. Glyph A, of course, is nothing more than Glyph E with a coefficient placed in a different position. This does not denote addition, as has been suggested, for in that case Glyph E would also have its coefficient placed below or to the right. I think this change in the position of the coefficient serves to differentiate Glyph A from Glyph E.

"This evidence of the glyphs themselves is not conclusive, but does, I think, give support to the thesis that the Maya lunar count of the inscriptions started from new moon." Mr. Thompson's suggestion is valuable, and in accordance with our admittedly inadequate knowledge of Maya psychology. It is still only a hypothesis and can not be considered irrefutable until a careful comparative analysis has been made of all existing examples of these glyph forms.

A somewhat indirect form of evidence is found in the manuscripts and has been referred to by Dr. Teeple.[5] There is reason to believe that the Maya Venus count was from the time the new Venus appeared after conjunction with the sun. By analogy, according to Teeple, we expect the moon count to be from new moon immediately after conjunction. Dr. Willson explains the Venus configuration referred to and adds "This conjunction is called 'inferior conjunction' and is much more striking than that between second heliacal rising and first heliacal setting on account of the great brilliancy of the planet and of the rapidity with which it passes from evening star to morning star."[6] Both Drs. Spinden and Ludendorff feel that the analogy is not well taken, but give no specific reasons.[7] The analogy between the two phenomena which Dr. Teeple probably had in mind was the first appearance of both celestial bodies after conjunction with the sun. But with that, the analogy ceases, for the actual observational phenomena do not seem to be similar, because Venus, after inferior conjunction, first appears on the eastern horizon just before sunrise, and, rising earlier each day, appears to be moving westward away from the sun with the passage of time; while the moon, after conjunction, first appears as a crescent on the western horizon just after sunset, and, rising later each day, appears to be moving eastward away from the sun with the passage of time. The validity of the analogy is a matter of opinion, and does not serve, therefore, as conclusive evidence.

This discussion raises a point which, as far as I know, has never been discussed. If the Maya began their Venus count when Venus first appeared as morning star just before dawn, is it possible that the lunar month was begun on the day that the crescent moon was last seen in the east just before dawn—that is, just *before* the moon's conjunction with the sun? If such were the case, Mr. Thompson's suggestion would be strengthened, for then full moon would be more nearly twenty days after the beginning of the lunar month.

The final group of data applicable to this question is found in the lunar table of the manuscripts. The following brief statement of the characteristics of this table on pages 51 to 58 of the Dresden Codex contains only such points as are agreed upon by all students. It consists of a series of numbers constantly increasing in value by intervals of 148, 177 and 178 days. We know these intervals refer to days because associated with each total are the proper three consecutive days from the repeating 260-day calendrical cycle. The three intervals are close approximations of five and six lunations and are so arranged that the recorded totals agree with modernly computed eclipse intervals with an error of not more than one day over a total period of 11,960 days, slightly more than 33 years. The record is unquestionably an eclipse record, and therefore the intervals were counted from either new or full moon, the only phases at which eclipses can occur. Is there any internal evidence to show to which phase of the moon the table refers?

Before proceeding further it is necessary to present certain data concerning eclipses as used in modern astronomy, and tabulated in Oppolzer's canon.[8] Examination of these tables, without reference to a specific locality, makes apparent at once that there is a definite periodicity in the phenomena. Lunar eclipses may occur at six lunation intervals five, six or seven times in succession. Then follows a period of no eclipses which usually covers 17 lunations, but sometimes only 11. This is followed again by lunar eclipses at six lunation intervals. There is also a larger periodicity permitting a grouping of 88, 94, 135, 223, 270 and other multiples of lunations.

The situation with regard to solar eclipses is similar. Such eclipses occur at six lunation intervals five, six or seven times in succession. In the inter-

[5] Teeple, *loc. cit.*, p. 49.

[6] Willson, *loc. cit.*, p. 9.

[7] Ludendorff, *loc. cit.*, 1931, p. 13; H. J. Spinden, "Maya Dates and What They Reveal," The Museum of the Brooklyn Institute of Arts and Sciences, *Science Bulletin*, Vol. iv, No. 1, 1930, p. 41.

[8] Th. von Oppolzer, "Canon der Finsternisse," Denkschriften Keiserl. Akad. Wissensch. Math.-Naturw. Klasse. lii, Wien, 1887.

vening 17 lunation periods there may be three to five eclipses at 5, 6, 11, 12 and 17 lunations. Those within one lunation of each other are never visible at the same point on the earth. It is clear that since these smaller intervals are the same as in lunar eclipses the larger groupings apply equally well to both solar and lunar eclipse phenomena.

It is relatively simple to explain the absence of lunar eclipses over a 17 lunation period, and the presence of solar eclipses in a similar period by modern astronomical knowledge, and an exposition of the concept of the "moon's node." The manuscript lunar table contains five lunation intervals, but no definite 11 or 17 lunation interval.

Dr. Teeple has presented a detailed and scholarly exposition of the thesis that the table can only be a solar eclipse table.[9] By plotting the dates given in the table upon a chart showing their occurrence in the 260-day calendrical period, two of which closely approximate one and one half eclipse years, he demonstrates that certain of the dates given fall beyond the limits of possible lunar eclipses, but are possible dates for solar eclipses. He reasons that, since these dates are recorded, and since a variation in the symmetry of the table in the last third prevents one of them from falling beyond the limits of solar eclipses, the table definitely concerns solar rather than lunar eclipses.

There is no single locality at which all solar and lunar eclipses are visible. Speaking in general, solar eclipses are more frequent than lunar ones, but with reference to a single locality, lunar eclipses are far more frequent than solar ones because of the narrow paths of the latter. From a knowledge of eclipse phenomena with reference to a specific locality it is evident that eclipses of either kind could not have been visible in the Maya area at each of the dates given in the manuscript in succession. The manuscript lunar table is, then, a compendium of eclipse knowledge, irrespective of the question of whether or not it refers to a specific series of eclipses. A number of the dates in the text could not record eclipses during any given 11,960 day period.

Since the 135 and 405 lunation interval is equally applicable to the periodicity of both types of eclipses, it is possible to coordinate the manuscript table with lunar eclipses. When this is done and the lunar eclipse dates charted upon a form similar to that used by Dr. Teeple, it is found that those dates on which no lunar eclipses can occur are those adjacent to the 148-day intervals in the manuscript, *i.e.*, the 11 or 17 lunation period is represented in the table by one or two six-lunation groups and a five-lunation group. This situation is characteristic of each of every one of the five-lunation groups.

[9] Teeple, *loc. cit.*, pp. 86–93.

It is known that the Mayas counted by six-lunation intervals several centuries prior to the creation of this table. Since the table corresponds so closely to eclipse phenomena, the Mayas probably knew of the 11 or 17 lunation interval without lunar eclipses. Because of the Maya habit of grouping in six-lunation groups, and knowing that every group in the table could not represent an eclipse date at any given time, the division of the 11 or 17 lunation interval into one or two groups of six lunations and one of five lunations is to be expected. The only other way of constructing a lunar eclipse table of this type would be to use the 11 or 17 lunation interval as a unit between groups of five, six or seven intervals of six lunations each. It might even be argued that the relation to solar eclipses of those dates adjacent to the five-lunation interval is only a coincidence, were it not for the conspicuous display in the "introduction" to this table, of Tzolkin dates fifteen days apart, covering, a two-lunation interval. I assume it is clear that, since solar and lunar eclipses can only occur at new or full moon, the interval between any given solar and the nearest lunar eclipse is a multiple of complete lunations plus approximately fifteen days.

It is evident, then, that the lunar table in the manuscript may be correlated with either solar or lunar eclipses. This has been done for solar eclipses by Drs. Willson[10] and Teeple,[11] and for lunar eclipses by Dr. Ludendorff.[12] Dr. Willson found that noteworthy coincidences between the manuscript record and the modern table of solar eclipses occurred seventeen times in about fifteen centuries.[13] Dr. Ludendorff placed the manuscript lunar table at one point in the Julian Day count at which there is complete agreement with lunar eclipses, except for one date. Had he placed it 3,987 days earlier he would have had complete agreement. He also found that equally satisfactory agreement could be obtained at 46 places over a period of about 400 years.[14]

The lunar table of the manuscripts, therefore, not only fails to give conclusive evidence regarding which phase of the moon was used as the beginning of the Maya lunar month, but also is found to be an eclipse table so accurately computed and so complete that it can be integrated into the Julian Day count at a large number of places, and still be in agreement with either solar or lunar eclipses. It is a computed table rather than a table of observed phenomena.

Our investigation of the question whether the

[10] Willson, *loc. cit.*, pp. 13–16.

[11] Teeple, *loc. cit.*, pp. 87–91.

[12] H. Ludendorff, "Uber die Reduktion der Maya-Datierungen auf unsere Zeitrechnung," Sitzungsberichten der Preussischen Akademie der Wissenschaften, Phys.-Math. Klasse. 1930. xviii, pp. 7–9.

[13] Willson, *loc. cit.*, p. 16.

[14] Ludendorff, *loc. cit.*, 1930, p. 9.

Mayas counted lunar months from new or full moon has revealed that the data at present available in comparative chronology, European-Maya records, and indigenous Maya records are not conclusive. It is clear that the phases of the moon at which eclipses might occur were used as the starting point for the Maya lunar month. But no irrefutable evidence has yet been found to indicate which of the two phases of new or full moon was used. The major part of the evidence tends to indicate that the Maya probably began their lunar months at new moon, but no proof of this has yet been found.

Therefore, the exclusive use of either phase of new or full moon as the beginning of the Maya lunar month is not a valid premise at the present time upon which to base conclusions concerning Maya astronomical records.

In considering the question of the existence of a computed lunar calendar at the time of the inscriptions it is necessary to analyze the available data. In order to simplify the problem I have used only the following two groups of indigenous data:—the manuscript lunar table and the Supplementary Series records during the Period of Uniformity, which have been made available in convenient form in Dr. Teeple's Table 3.[15] The following adjustments have been made in this table: Two dates have been omitted because of apparent contradictions, namely, those on Lintel 26 at Yaxchilan and on Lintel 1 at El Cayo; Two dates have been added, The Temple of the Initial Series No. 15 at Holactun, using Mr. Thompson's reading 9.15.12. 6. 9,[16] and Lintel 3 at Piedras Negras, newly discovered and beautifully exhibited by the University of Pennsylvania Museum. It bears the date 9.15.18. 3.13.

The manuscript gives an arrangement of five- and six-lunation groups, containing 148, 177 and 178 days. The inscriptions record that during the Period of Uniformity the lunations were arranged by sixes only.[17] Combining these two groups of data gives the first premise; During the Period of Uniformity the Maya lunar count was in groups of six lunations each, containing either 177 or 178 days, and an additional period of five lunations containing 148 days was used at the time of the writing of the manuscript.

The manuscript contains no information concerning any subdivisions of these groups. Glyph A of the Supplementary Series does record that these groups were divided into months of 29 and 30 days. There is no evidence of the use of any months of either 28 or 31 days.

[15] Teeple, *loc. cit.*, pp. 50–51.
[16] J. E. Thompson, "Archeological Investigations in the Southern Cayo District, British Honduras," Field Museum of Natural History. Publication 301; Anthropological Series, Vol. xvii, No. 3, 1931, pp. 354–356.
[17] Teeple, *loc. cit.*, pp. 53–61.

Dr. Teeple gives a free reading of a combined Initial Series and Supplementary Series, from which I quote the interpretations of glyphs E, D, C and A: " . . . the age of the moon is 20 days from the last new moon, and it is 20 days and one moon since this lunar half year began; . . . and this present moon will probably end as a 30-day moon."[18] You will note that he includes a reference to new moon, which I feel is not justified. The readings of glyph E, D and C are in terms of elapsed time, that of glyph A in current time. The data of the Maya calendar are overwhelmingly in favor of the assumption that the Mayas counted in elapsed time only, at least during the days of the Old Empire. I therefore suggest a revised translation of these sections, as follows: " . . . the age of the moon is twenty days from the end of the last lunar month; there has been one complete month since the ending of the last lunar half-year; . . . the last complete month contained 30 days."

Dr. Teeple has pointed out that "Whenever glyph C has an odd coefficient, 1, 3 or 5, the chances are about three to one that glyph A will show 30 days; whenever glyph C has an even coefficient, 2, 4 or 6, the chances are about three to one for a 29-day glyph A."[19] If my reading of glyph A is correct, then this relationship indicates that normally the six-lunation periods were divided into six months arranged in alternation containing 30, 29, 30, 29, 30, 29 days each, thereby closely approximating actual lunations in terms of whole days. Moreover, such an alternation creates the totals of 177 and 148 for the lunation groups as found in the manuscript. My second premise is then: The five- and six-lunation groups were normally divided into an alternating series of 30 and 29 days, beginning with one of 30 days.

The manuscript lunar table states that at the time it was made the Mayas computed that 405 lunations equalled 11,960 days. Dr. Teeple has demonstrated that during the time of the inscriptions the Mayas used the equivalents of two other computations, namely, 149 lunations equaled 4,400 days, and 81 lunations equaled 2,392 days.[20] But an unbroken alternation of 30 and 29 day months for these periods give respectively 11,948, 4,396 and 2,390 days, *i. e.*, 12, 4 and 2 days less than the Maya records show. The Maya computations approximate the true lunation intervals more closely than the straight alternation. They must therefore have added intercalary days probably at more or less regular intervals. The existence of 178-day groups in the manuscript and the occurrence of two cases of even months with 30 days

[18] *Ibid.*, p. 64.
[19] *Ibid.*, p. 63.
[20] *Ibid.*, pp. 64–67.

in the Supplementary Series supports this conclusion.

Since no record exists of 179- or 180-day groups, and since no record exists of 31-day lunar months, my third premise is: The Mayas never added more than a single intercalary day in any six-month group, and this was done by changing a 29-day month to a 30-day month.

The only data we have which may indicate the intervals at which the intercalary days were added is contained in the manuscript table. Such isolated examples of even numbered months of 30 days in the Supplementary Series are too widely separated in time to be of assistance. Following the method used in my article on the manuscript lunar table,[21] an alternating series of 30 and 29 days can be applied to this record, and the intercalary days arbitrarily added in such six- and five-month groups as are necessary to have the sequence conform to the totals given in the table. If the alternation is applied in 135-month groups, it is found that the intercalary days may be added in the same months in each third of the table, namely, the 32nd, 74th, 80th and 130th months. Unfortunately, there is no indication of which 29-day month in each group contained the intercalary day, so the possibility of the use of one of the other two 29-day months in each six-month group for this purpose must be kept in mind. Due to irregularities which must be taken into consideration it is necessary to use the entire 11,960-day table rather than one of one third this length.

But the manuscript table can not be applied to the record of the inscriptions as it stands because of the existence of five-month groups, which were not used during the Period of Uniformity. We can, however, group the month table which has been made to fit the data of the manuscript into six-month groups only, without altering either the sequence or the value of the months. 135 and 405 months are not divisible by six, but twice each of these periods are respectively 45 and 135 six-month groups, by the use of which a repeating cycle in six-month groups will be obtained. The six-month groups of the second, fourth and sixth thirds of the manuscript table begin with a 29-day month instead of a 30-day month, in disagreement with a part of my second premise.

It is, of course, clear that I am preparing to apply the manuscript lunar table to the record of the Supplementary Series. This latter record must also be analyzed. Glyphs E, D and C give the age of the moon at the time of the related Long Count date, in terms of months and days since the end of the last lunar half-year. In translating the months into days we must consider the possibility that any one of the 29-day months may have contained an intercalary day. Therefore, wherever glyph C records more than one month, we must use two adjacent values for the number of days corresponding to the month record. For example, if glyph C records three months, the number of days would normally be 30 + 29 + 30 or 89 days, but if the 29-day month contained an intercalary day, there would be 90 days in the three months. By subtracting the record of glyphs E, D and C from the associated Long Count date, the "lunar base" or the end of the last complete lunar half-year is obtained in terms of two adjacent dates in the Long Count.

We now have a table of months arranged in terms of lunar half-years, which conforms to the data of the manuscript lunar table, and a series of dates in the Long Count which record the ending of lunar half-years during the Period of Uniformity. These two groups of data may be charted in terms of lunar half-years and compared directly, by a method similar to that used by Dr. Willson.[22] In order to prevent confusion, the dates from the various cities have been charted separately.

There are 28 dates between 9.13. 5. 0. 0 and 9.16. 1. 0. 0 which conform to the requirements of the Period of Uniformity, and no dates which do not do so. Thirteen of these occur at Piedras Negras, giving us the best critical series for a test. The application of the manuscript lunar table in terms of 30- and 29-day months fits this group of dates from Piedras Negras exactly, with a single exception, that on Stela 5, where the reading for glyph D is uncertain. Dr. Teeple says of it, "the age is surely over 10 and not over 15, while 15 is expected."[23] The manuscript table demands glyph D have the number 16. A very slight adjustment in the manuscript table of the intercalary day in the 130th month of the sixth third will eliminate this possible error.

There is a day-for-day agreement, except for a single doubtful reading, between the record of glyphs E and D in the inscriptions at Piedras Negras during the Period of Uniformity, and a month-for-month arrangement of the manuscript lunar table.

When the entire range of the Piedras Negras dates conforming to the Period of Uniformity is considered, we have 19 dates ranging over a period from 9.11.12. 7. 2 to 9.18. 0. 3. 1, a total of 45,999 days, or nearly four times the length of the manuscript lunar table. There are only four of the 19 dates which do not give an exact correlation, and all four record a dif-

[21] C. E. Guthe, "A Possible Solution of the Number Series on Pages 51 to 58 of the Dresden Codex," Papers of the Peabody Museum of American Archeology and Ethnology, Harvard University. Vol. vi, No. 2, 1921, pp. 21–24.

[22] Willson, *loc. cit.*, pp. 13–15.

[23] Teeple, *loc. cit.*, p. 52.

ference of only one day from that expected. In each case this error of one day is adjusted during the next few lunar half-years of the table.

A similar examination of the four dates at Naranjo reveals complete agreement without exception. Of the seven dates at Copan, five are in exact agreement, and the other two are one and two days at variance respectively, but again are corrected during the following few lunar half-years. The starting date for the lunar table is a different one for each city. At Piedras Negras it is the lunar base for 9.12. 2. 0.16, which is recorded twice with different moon ages, and at Copan it is the lunar base for 9.12. 8. 3. 9, which is used as the basis for lunar computations on Altar H′.

At Piedras Negras two monuments record Initial Series identical to two at Copan. In the first case, 9.13.10. 0. 0, the moon age at Piedras Negras is given as two days more than at Copan. In the second, 9.15. 5. 0. 0, identical moon ages are recorded. All four of these dates fit exactly into the manuscript month series. The apparent contradiction is caused by the fact that the month grouping used is engaged into the Long Count at different points in the two cities.

It is demonstrable, therefore, that a 135-month cycle of 30- and 29-day months, so arranged as to conform to the groups of the manuscript lunar table, may be applied to the records of the inscriptions in such a way as to cause a day-for-day agreement between it and the records given in glyphs E, D and C of the Supplementary Series, with a very few exceptions, which are all corrected in succeeding lunar half-years. At Piedras Negras this 135-month cycle must be repeated twelve times.

As it is used, this 135-month cycle does not conform with the record of glyph A, because at every other repetition of the cycle the half-year group starts with a 29- instead of a 30-day month. By using twice this cycle, or one of 270 months, grouped in two parts of 134 and 136 months each, in which the intercalary days occur in the first 132 months of each part in exactly the same positions as in the first 132 months of the manuscript table, an agreement with the glyph A record can be secured.

It must not be overlooked that as soon as adjustments are made, the possibilities for alternative adjustments increase. The fitting of the manuscript table into the inscriptions demonstrates that the record given in glyphs E and D may be a computed record, and is not, therefore, necessarily an observational one. I am convinced that other computed cycles can also be found which will fit the mathematical records of the Supplementary Series.

This paper is of necessity a brief review of my findings, and does not attempt to be exhaustive. The indigenous records of the Maya lunar count still contain many interesting unsolved problems.

My general conclusions at the present time are: first, the Maya lunar month began at either new or full moon, but the data available at present does not permit the exclusive use of either phase for the beginning of the Maya lunar month as a premise in deducing conclusions regarding Maya astronomy; and second, it can be demonstrated that the numbers associated with glyphs E, D, C and A of the Supplementary Series of the inscriptions may have been obtained by the use of a computed lunar calendar, and need not, therefore, be records of current contemporaneous observations.

OBITUARY

EDWARD ORTON, JR.

GENERAL EDWARD ORTON, JR., died at his home in Columbus, Ohio, on February 10. With him a most distinguished and unique career is closed. He was the founder of the first course in ceramic engineering which he established at the Ohio State University in 1894. He was a powerful and able investigator in the field of economic geology, ceramics and silicate technology, in which he was a pioneer. In 1898 Orton founded the American Ceramic Society which he served as secretary and editor for many years, and was its president as recently as 1930–31. His efforts were mainly responsible for the creation of a fruitful American literature on the subject of ceramics. He served the Ohio State University twice as dean of the College of Engineering, was active in the establishment of the Engineering Experiment Station, and in 1916 was elected one of the university's two first research professors. He was state geologist of Ohio from 1899 to 1906, during which time he placed the Ohio Survey on a firm basis and published a series of monographs. General Orton created the Orton Geology Library at the Ohio State University in memory of his father. He left the university when America entered the war, and despite his age, he had gone to the Plattsburg training camp. He was subsequently commissioned a major and later a colonel. His work in the Motor Transport Division was of such an outstanding character that Congress awarded him the Distinguished Service Medal. He was later made a brigadier general in the reserve corps. General Orton received many honors. He was given the honorary D.Sc. degree by Rutgers University in 1922 and the LL.D. degree by Alfred University in 1931. He

was a fellow of the Geological Society, the American Association for the Advancement of Science, the American Ceramic Society, and an honorary member of the Ceramic Society of England.

Edward Orton was born at Chester, New York, in 1863 and was brought to Ohio in 1865. His father was the eminent geologist, Dr. Edward Orton, Sr., the first president of the Ohio State University.

The life of young Edward Orton was thus intimately connected with the growth of the university to which he gave his lifelong devotion. He was graduated in 1884, in the course of mining engineering and metallurgy. He was equally attached to the city of Columbus, which he served in many capacities, in the field of civics and in the cause of its charities. For two terms he was president of the chamber of commerce. He was known as Columbus' First Citizen.

General Orton leaves his widow, Mrs. Althea Orton; two sisters, Mrs. Oliver P. Watts, of Madison, Wisconsin; Mrs. Francis C. Caldwell, of Columbus, and a brother, Dr. Samuel T. Orton, of New York City.

Dr. Orton was an extraordinary man. He combined the ability of the scientist with that of the executive, and he showed rare skill in anything he undertook. He was passionately devoted to science and most humble in its service. He was, by nature, a lover of mankind, an American gentleman of the highest type, a lover of truth and justice, a broad thinker, an altruist, a striver after the beautiful. He was a man who singularly combined the qualities of strength and great personal kindness and charm. Dr. Orton's influence upon his students and associates was a powerful one and he invariably gained the respect and affection of all with whom he came in contact.

His departure is a sore loss not only to his family but to his university, his city, his state, the nation, the American Ceramic Society with the industries it represents, and to all who have felt his benign presence.

A. V. BLEININGER

RECENT DEATHS

FREDERICK LANE HUTCHINSON, national secretary and executive manager of the American Institute of Electrical Engineers, died on February 26 at the age of sixty-six years.

DR. WILLY MEYER, emeritus professor in the New York Post-Graduate Medical School and Hospital, died on February 24 while attending a meeting of the New York Surgical Society, where he had made an address on "Special Aspects of Cancer and Its Treatment." He was seventy-three years old.

DR. CHARLOTTE ANGUS SCOTT, professor of mathematics at Bryn Mawr College from 1885 to 1917, who had been living at Cambridge, England, since her retirement, died on November 8 at the age of seventy-three years.

HOWARD E. BOARDMAN, Dudley professor of railway engineering at Yale University, died on February 28 at the age of fifty-two years.

HUGH GIBB, chief preparator in vertebrate paleontology at Yale Peabody Museum, with which he had been connected for fifty years, died on February 28, at the age of seventy-two years.

PROFESSOR J. FIDEL TRISTAN, director of the National Museum at San Jose, Costa Rica, died on January 23.

SIR WILLIAM SOMERVILLE, professor emeritus of rural economy at the University of Oxford, died on February 18 at the age of seventy-one years.

SIR ARTHUR DUCKHAM, president-elect of the Federation of British Industries and a founder of the British Institution of Chemical Engineers, died on February 14 at the age of fifty-one years.

PROFESSOR R. STENHOUSE WILLIAMS, first director of the British National Institute for Research in Dairying, and research professor in dairy bacteriology in the University of Reading, died on February 2, aged sixty years.

PROFESSOR WILLIAM BILLINGTON, professor of surgery in the University of Birmingham, has died at the age of fifty-six years.

PROFESSOR ERNEST WILSON, emeritus professor of electrical engineering at King's College, London, since 1930, died on February 17.

SIR FREDERICK WILLIAM ANDREWES, emeritus professor of pathology at the University of London, died on February 24, at the age of seventy-two years.

GUILLAUME BIGOURDAN, formerly director of the Paris Observatory, died on February 29 at the age of eighty-one years. He was a member of the French Academy of Sciences and had served as president of the Bureau of Longitudes.

THE death is announced at the age of fifty-three years of Dr. Benjamin Lipschütz, professor of dermatology and syphilology at the University of Vienna.

A CORRESPONDENT writes: Dr. Ferdinand Canu, paleontologist of Versailles, France, died suddenly February 12, 1932, of cerebral hemorrhage. Born December 10, 1863, at Paris and educated there he was instructor in mathematics and sciences in the Paris schools until his retirement in 1914. His first scientific work was a text-book on meteorology, which was followed by an atlas of fifty plates on paleogeography,

the first ever published. Paleontological studies then claimed his attention, resulting in many important papers, especially upon Mesozoic Bryozoa. In 1912 began the joint studies with Dr. R. S. Bassler, of the Smithsonian Institution, which have continued to date and have resulted in various monographs upon fossil and recent Bryozoa. Dr. Canu was the recipient of the Elliott Medal of the National Academy of Sciences for his quarto volumes on "The Tertiary Bryozoa of North America."

SCIENTIFIC EVENTS

ANTI-VIVISECTION ACTIVITY

THE committee of the American Psychological Association on Precautions in Animal Experimentation, consisting of Drs. C. J. Warden, E. G. Wever and W. T. Heron, *chairman*, has addressed the following letter to members of the association:

There has been introduced to the Senate of the Congress of the United States, Senate Bill 2146, dated December 17, 1931, which reads as follows:

> Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That from and after the passage of this Act it shall be a misdemeanor for any person to experiment or operate in any manner whatsoever upon any living dog, for any purpose other than the healing or curing of said dog, in the District of Columbia.
>
> Sec. 2. That any person convicted of a violation of this Act shall be sentenced to pay a fine of not less than $100 nor more than $500, or to undergo imprisonment for a term of not less than three months nor more than one year, or both such fine and imprisonment.
>
> Sec. 3. That all Acts or parts of Acts inconsistent herewith are hereby repealed.

This bill is most drastic since it is leveled against *all* experimentation, not only operative work. Should the organizations backing the bill be successful in Congress, their efforts to force similar bills through the various state legislatures would be greatly facilitated.

A similar bill, H–261, has been introduced in the legislature of New York State, and another bill, S–132, was introduced in the legislature of Massachusetts on January 18, 1932. Efforts toward legislation of this sort are on the increase and are backed by powerful organizations. These attempts at making laws to restrict scientific investigation should be combatted by every member of the American Psychological Association. On the other hand, these attempts to make laws to restrict scientific investigation should be a further warning to every person who conducts or directs experiments upon animals. Every precaution must be taken in the conduct of experiments to see that there can be no possible justification for the arguments used in support of these restrictive measures.

It is hoped that each member of the American Psychological Association will voice his protest against the passage of the bill before Congress by writing to his respective senators and representatives. Similar action should be taken with reference to state legislators by those members living in states where bills of this nature are under consideration.

THE AMERICAN SCHOOL OF PREHISTORIC RESEARCH

THE twelfth annual summer term of the American School of Prehistoric Research will open in Berlin on July 1 and close at Starcevo, near Belgrade, Yugoslavia, on August 31. July will be spent in a study of museum collections and excursions to prehistoric sites, including experience in digging at Neolithic and Eneolithic stations in Hungary. The month of August the students will dig at Starcevo, where Neolithic, Bronze and Hallstatt cultures are all represented. The summer term will be in charge of Dr. V. J. Fewkes, assistant director of the school and director of the Harvard-American School of Prehistoric Research, Central European Expedition. The tentative program is as follows:

July 1. 10 A. M. Museum für Völkerkunde, 110 Stresemann Strasse, Berlin.
2. Berlin.
3. Silesian Museum, Breslau.
4. Breslau to Prague.
5. National Museum, Prague.
6. Hanspaulka Museum, Prague.
7. Moravské Zemské Museum, Brno.
8. Same.
9. Brno to Vienna; P. M., Naturhistorisches Museum.
10. Vienna; night boat for Budapest.
11. National Museum, Budapest.
12. Same.
13. Day of rest in Budapest.
14. Budapest to Tisza valley.
15–28. Excavations at Neolithic (Bükki) and Eneolithic (Tisza II) stations.
29. Arrive Belgrade; National Museum.
30. Visit Vinca and the Vasic Laboratory.
31. Leave for Starcevo.

August 1 to 31. Excavations at Starcevo.

For the last two weeks of August, students have the option of remaining at Starcevo, or of a self-conducted excursion *via* Zagreb to the Pyrenees, Dordogne and Paris.

No enrolment fee is charged to students from institutions which are supporting members of the school. Students from other institutions pay an enrolment fee of $50. The round trip ocean fare (cabin or tourist third) can be had for about $225. The cost

of the two months on the continent is estimated at $300 to $350.

Preference will be given to applicants who have a knowledge of French and German and who already have at least a bachelor's degree. Graduate students may receive university credit for the course to the extent of eight hours weekly for one semester.

Applications for enrolment and requests for further information should be addressed to: Dr. George Grant MacCurdy, Director of the American School of Prehistoric Research, Peabody Museum, New Haven, Connecticut.

THE NEW YORK ASSOCIATION OF BIOLOGY TEACHERS

DURING the current year the New York Association of Biology Teachers has considerably expanded its activities. Started over thirty years ago in an organization meeting of twelve New York high-school teachers, it now numbers nearly six hundred. While most of its members are teachers from the forty-one senior and nearly seventy junior high schools, a considerable fraction represent university and research institutions, and an increasing number of its members work in institutions outside New York City. Its president for the current year is Mr. Paul B. Mann, chairman of the biology department at Evander Childs High School, and associate at the American Museum of Natural History.

Beginning in October, 1931, the association started the publication of a printed bulletin, *The Teaching Biologist*, under a newly appointed editorial committee. This is scheduled to appear in eight issues during the current academic year. So far, five issues have appeared, four 4-page and one 6-page. These contain abstracts of the addresses delivered before the regular monthly meetings, book reviews, brief notes on new demonstration methods, announcements, etc. Any one interested to obtain a sample copy should address Miss May-Eunice Emanuel, James Madison High School, Brooklyn, N. Y.

The association carries on a diversified series of activities. Its regular monthly evening meetings are usually attended by three to four hundred people. Working through special committees, a series of special field and institutional trips are carried out during the year. Other committees are working on equipment and pedagogy and new course syllabi. A committee of members serving as the official high school Hygiene Syllabus Committee has recently completed three new courses in hygiene, "Personal," "Home and Community" and "Personality Studies." The first two have been in print for two years; the third is now in press. Another syllabus committee has recently prepared a new syllabus for ninth-year biology which is being tried out widely in the city and state. Still another committee is working on an "advanced zoology" syllabus, and another on a revision of the "advanced biology" which is the present New York City tenth-year biology course. The new state syllabus in general biology was prepared by a committee, all the members of which are members of the New York Association.

The program committee has enlisted the following speakers for the 1931–1932 program.

October—Dr. L. T. Hopkins, "The Science Curriculum; What, How and for Whom?"
November—Dr. Henry C. Sherman, "Recent Advances in the Chemistry of Nutrition."
December—Dr. Cecil Yampolsky, "Sex Intergrades in *Mercurialis annua*"; Dr. Ralph C. Benedict, "Plant breeding, Old and New."
January—Dr. C. C. Little, "The Eugenic Viewpoint."
February—Dr. F. E. Denny, "Plant Stimulants and Hormones."
March—Dr. A. L. Kroeber, "Man as a Species."
April—Dr. M. W. Smallwood, "The History of the Reflex Action."

THE SOUTHWESTERN DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE annual meeting of the division will be held in Denver, Colorado, on April 25, 26, 27 and 28. Announcement of any paper to be read should be made to the chairman of the section concerned (see list below), and must be accompanied by a short non-technical abstract.

Since these abstracts should be in the hands of the secretary of the division before March 15, it is urged that members submit papers to their section chairman at the earliest possible moment.

For the information and guidance of members, the following arrangements are indicated:

SECTION OFFICERS

Biological Sciences: Miss Edna Johnson, University of Colorado, Boulder, *chairman*.

Physical Sciences: W. W. Lake, Box 251–A, R. F. D. 1, El Paso, Texas, *chairman*.

Social Sciences: E. E. Renaud, University of Colorado, Denver, *chairman*.

Other Organizations: F. E. E. Germann, University of Colorado, *chairman*.

Symposium: "Adjustment of Educational and Scientific Endeavor in the Light of Changed Economic Conditions." J. G. Brown, University of Arizona, Tucson.

Symposium: "Recent Advances in Science." John D. Clark, University of New Mexico, Albuquerque.

It is urged that all committees and others in charge of meetings, lunches, selection of committee members, etc., should send all program material to the division secretary not later than March 15.

COMMITTEES

Committee on Resolutions: F. J. Crider, Superior, Arizona, *chairman.*

Committee on Exhibits: C. A. Heiland, University of Denver, *chairman.*

Committee on Reception: R. E. Nyswander, University of Denver, *chairman.*

Committee on Press Service: J. H. McLennan, University of Denver, *chairman.*

Committee on Registration: R. G. Gustavson, University of Denver, *chairman.*

Committee on the Sigma Xi Dinner: M. H. Reese, University of Denver, *chairman.*

The executive committee has ruled that a registration fee of $1 shall be charged.

Further announcement concerning arrangements will be made at the earliest possible date.

M. R. SCHNECK,
Secretary

UNIVERSITY OF ARIZONA, TUCSON

THE PACIFIC DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE sixteenth annual meeting of the Pacific Division, American Association for the Advancement of Science, is to be held at the State College of Washington, Pullman, from June 15 to 18. The following affiliated and associated societies intend to join in the meeting through the holding of scientific sessions:

American Association of Economic Entomologists, Pacific Slope Branch. *Secretary:* H. A. Scullen, Oregon State College, Corvallis, Oregon.

American Chemical Society, Pacific Intersectional Division. *Chairman, Program Committee:* J. L. St. John, State College of Washington, Pullman.

American Meteorological Society. *Secretary:* Edward H. Bowie, U. S. Weather Bureau, San Francisco, California.

American Physical Society. *Local Secretary for the Pacific Coast:* Leonard B. Loeb, University of California.

American Phytopathological Society, Pacific Division. *Secretary:* B. A. Rudolph, Box 232, San José, California.

American Society of Ichthyologists and Herpetologists, Western Division. *Secretary:* Geo. S. Myers, Department of Zoology, Stanford University.

Astronomical Society of the Pacific. *Secretary:* C. H. Adams, 506 Merchants Exchange Building, San Francisco, California.

Botanical Society of America, Pacific Section. *Secretary:* F. DeF. Heald, State College of Washington, Pullman, Washington.

San Francisco Aquarium Society (joint meeting with Society of Ichthyologists and Herpetologists). *Secretary:* Mrs. Ethel Seale, Steinhart Aquarium, Golden Gate Park, San Francisco, California.

Society for Experimental Biology and Medicine, Pacific Coast Branch. *Secretary:* T. D. Beckwith, University of California.

Western Society of Naturalists. *Secretary:* E. G. Moberg, The Scripps Institution of Oceanography, La Jolla, California.

Western Society of Soil Science. *Secretary:* E. E. Thomas, Citrus Experiment Station, Riverside, California.

It is also hoped that a joint session of the Society of American Foresters, California, and North Pacific sections, and the western group of ecologists may be arranged. The Pacific Northwest section of the American Association of Cereal Chemists (J. L. St. John, State College of Washington, chairman of the program committee) is also expected to meet at Pullman during the third week of June.

Information concerning the presentation of papers or of other matters pertaining to the programs of the participating societies may be obtained from the secretaries mentioned above or from J. Murray Luck, secretary of the Pacific Division, American Association for the Advancement of Science, Stanford University, California. Correspondence regarding guest accommodation and matters of local arrangement should be addressed to W. E. Bradt, Department of Chemistry, State College of Washington, Pullman, chairman of the local committee.

SCIENTIFIC NOTES AND NEWS

DR. THEOBALD SMITH, who recently retired as director of the department of animal pathology of the Rockefeller Institute for Medical Research at Princeton, has been elected a corresponding member of the Paris Academy of Sciences.

DR. LAFAYETTE B. MENDEL, professor of physiological chemistry at Yale University, is honored in the March issue of the *Yale Journal of Biology and Medicine*, which is dedicated to him. This issue is called "The Mendel Anniversary Number" in recognition of the sixtieth anniversary of his birth, and contains eighteen papers written by leading scientific men. The *Journal* has as a frontispiece the portrait of Professor Mendel executed by John Quincy Adams and presented to him by four hundred former students and associates on his sixtieth birthday.

DR. WARREN WEAVER, professor of mathematics at the University of Wisconsin, was on February 1 appointed director for the natural sciences in the Rockefeller Foundation and in the General Education

Board. He succeeds Dr. Herman Augustus Spoehr, who has resumed work with the Carnegie Institution of Washington.

DR. ALBERT EINSTEIN, who has been visiting professor at the California Institute of Technology, sailed from San Francisco for Germany on March 4.

DR. SVEN HEDIN, who has been visiting the United States, sailed for China on March 3.

SIR F. GOWLAND HOPKINS, Sir William Dunn professor of biochemistry at the University of Cambridge, has been granted leave of absence with stipend for such one term as the general board may approve in each academic year in which he holds the office of president of the Royal Society.

AT a recent meeting of the Royal Astronomical Society, Dr. H. Knox-Shaw, Radcliffe observer, Oxford, was reelected president. New members of the council elected are Mr. C. R. Davidson, Sir Arthur Eddington, Mr. John Evershed and Dr. R. Stoneley.

DR. E. A. HOLBROOK, dean of the School of Engineering and Mines, University of Pittsburgh, has been elected president of the Coal Mining Institute of America.

DR. GEORG GEYER, emeritus director of the Austrian Geological Survey at Vienna, celebrated his seventy-fifth birthday on February 20.

DR. ADOLF SCHMIDT, formerly director of the Meteorological-Magnetic Observatory at Potsdam, will celebrate the fiftieth anniversary of his doctorate on March 20.

DR. ALBERT HASSALL, senior zoologist and assistant chief of the zoological division of the Bureau of Animal Industry, who has been in the bureau for forty-four years, was honored recently by a gathering in Washington of fifty-five scientific workers of the department and others engaged in related technical fields. The speakers on the occasion were Dr. U. G. Houck, associate chief of the bureau; Dr. M. C. Hall, chief of the zoological division; Dr. Benjamin Schwartz, senior zoologist; Dr. N. A. Cobb, Bureau of Plant Industry; Dr. Paul Bartsch, National Museum, and Dr. W. W. Cort, the Johns Hopkins University. Dr. Hassall has specialized in the compilation of index catalogues of zoological literature descriptive of more than 50,000 animal parasites. The author catalogue is being brought up to date, and the term of service of Dr. Hassall, who has just reached his seventieth year, has been extended to enable him to continue this work.

THE *Journal* of the American Medical Association reports the retirement of Dr. Albert Allemann at the end of February from active duty in the library of the surgeon general's office, where he has been since 1900. Dr. Allemann was born in Switzerland in 1860 and came to the United States in 1884. He entered the library in 1900 and began the study of medicine, graduating from George Washington University School of Medicine in 1904. Dr. Allemann was for fifteen years principal assistant librarian and editor of the "Index Catalogue." At one time he was assistant editor of the "Index Medicus" and later was on the staff of the "Quarterly Cumulative Index Medicus." Testimonials of the esteem and affection of his fellow workers at the library were presented to Dr. Allemann at the time of his retirement.

DR. WILLARD ROUSE JILLSON, director and state geologist of the Kentucky Geological Survey since 1918, resigned on February 15. During his administration 230 county and regional maps, principally in standard colors and at the scale of one inch to the mile, covering the entire commonwealth, were surveyed and published, 51 full and fractional U. S. Geological Survey topographical sheets, scale 1: 62,500, and three new colored geological, geographic and relief maps of Kentucky, scale 1: 500,000. During this time there were prepared and published 47 cloth-bound volumes and 27 pamphlets on the geology and mineral resources of Kentucky.

MR. DONALD SCOTT has been elected director of the Peabody Museum, Harvard University, to succeed Dr. Edward Reynolds. Mr. Scott has been assistant director of the Peabody Museum since 1929.

DR. GEORGE SAMUEL BOND, formerly of the Johns Hopkins University School of Medicine, has been named head of the newly organized department of cardiology at the Indiana University School of Medicine at Indianapolis.

MR. DON S. ANDERSON, of the division of agricultural economics at the University of Minnesota, has been appointed a member of the staff of agricultural economics at the Wisconsin College of Agriculture, the appointment to become effective on March 29.

DR. G. F. J. TEMPLE has been appointed to the chair of mathematics at King's College, London.

DR. GEORGE PACHER BERRY, who has been associated with the Rockefeller Institute for Medical Research, has resigned to become professor of bacteriology and assistant professor of medicine in the medical school of the University of Rochester.

DR. LIVINGSTON FARRAND, president of Cornell University, has been appointed a member of the Public Health Council of New York State by Governor Roosevelt, to succeed Dr. Jacob Goldberg, whose term of office has expired.

DR. ALEXANDER SILVERMAN, head of the chemistry department at the University of Pittsburgh, has been appointed a trustee of the American Ceramic Society.

MR. CHESTER RHINES, a graduate of North Dakota Agricultural College, has been appointed by the committee on the microbiology of the soil of the National Research Council to carry on investigations on the relation of amoeboid organisms to the development and persistence of acid fast bacteria in the soil, at the department of soil microbiology of the New Jersey Agricultural Experiment Station.

THE title of fellow of University College, London, has been conferred on Mr. Sidney George Brown, inventor of the Brown Gyro Compass and of the Frenophone; Dr. Harold John Channon, Johnston professor of biochemistry in the University of Liverpool, late biochemist on the staff of the department of experimental pathology and cancer research in the University of Leeds; Professor Henry Albert Harris, professor of clinical anatomy at University College and University College Hospital Medical School, Hunterian professor of the Royal College of Surgeons; Professor John Turner Macgregor-Morris, professor of electrical engineering at the East London College; Dr. Egon Sharpe Pearson, senior lecturer in the department of applied statistics and eugenics, University College, London; Professor Archibald Read Richardson, professor of mathematics in the University College of Swansea, late assistant professor of mathematics in the Imperial College of Science and Technology, and on Mr. Herbert Tilley, lately surgeon to the Ear, Nose and Throat Department of University College Hospital.

GRANTS made by the Committee on Scientific Research of the American Medical Association include: $1,000 to Dr. Ernest Carroll Faust, professor of parasitology in the Tulane Medical School, for a study of Strongyloides infections in man and other mammalian hosts; $650 to Dr. Wm. D. McNally, for a study of the effects of tobacco tar upon the lungs of rats and other animals; $400 to Dr. William C. Langston and Dr. Paul L. Day, of the School of Medicine, University of Arkansas, at Little Rock, for further investigations in vitamin G deficiency with particular reference to cataract, the monkey being the experimental animal; $500 to Dr. Israel S. Kleiner, professor of physiological chemistry at the New York Homeopathic Medical College and Flower Hospital, for the investigation of enzymes; $400 to Dr. Clinton H. Thienes, professor of pharmacology at the University of Southern California School of Medicine, for the continuation of his work on the intrinsic nervous system of the intestine; $250 to the departments of medicine and surgery, College of Medicine, University of Cincinnati, toward a study of temperature variations in different parts of the skin; an additional grant of $250 in order to continue an investigation of the problem of carbo-hydrate metabolism and cancer growth; $250 to Dr. M. S. Burman, of New York City, for the study of fluorescent phenomena in cartilage, and $200 to Dr. Nicholas A. Michels, of the Daniel Baugh Institute of Anatomy of the Jefferson Medical College, for work on erythropoiesis. Grants were also made to Dr. E. A. Smith, of the department of zoology at the Iowa State College, for a study of the effects of certain gases on the animal body, and to Dr. H. E. Himwich, of Yale University, for an investigation of the effects of alcohol on metabolism, and for the study of the regulation of metabolism by the autonomic nervous system.

DR. WARREN WEAVER, professor of mathematics; F. P. Woy, professor of engineering administration, and Dr. Gordon Ritchie, assistant professor of pathology, have been granted leave of absence from the University of Wisconsin, not from the University of Michigan, as was erroneously reported in SCIENCE.

MR. FRANK H. H. ROBERTS, JR., archeologist at the Bureau of American Ethnology, has been detailed to the Carnegie Institution of Washington to serve as consulting archeologist for excavations at Chichen Itza.

DR. J. ENRIQUE ZANETTI, professor of chemistry at Columbia University, will represent the Chemical Foundation of New York and synthetic nitrate interests in the United States in a survey of the Chilean Nitrate Industry.

DR. J. PAUL VISSCHER, head of the department of biology of Western Reserve University, left for Europe on March 8 to continue his work on barnacles. He plans to work at Naples until May and later at Plymouth.

MR. CARL O. ERLANSON and Dr. Howard MacMillan are members of an American research mission to Peru, whose principal object is the study and collection of fly pests which are attacking fruit-bearing shrubs and trees.

DR. C. B. WILLIAMS, lecturer in entomology at the University of Edinburgh, has been appointed professor of entomology at the University of Minnesota for the spring quarter. During that time he will give a series of lectures in advanced economic entomology. At the termination of this appointment Dr. Williams will return to England to become chief of the department of entomology at the Rothamsted Experimental Station.

PROFESSOR L. J. HENDERSON, of Harvard University, gave a public lecture on "The Influence of Galileo on Medical Science" on March 8.

DR. LESLIE T. WEBSTER, of the Rockefeller Institute, will deliver the sixth Harvey Society Lecture at the New York Academy of Medicine, on Thursday, March 17, on "Experimental Epidemiology."

DR. LEWELLYS BARKER, of the Johns Hopkins University, delivered the annual Alpha Omega Alpha Lecture at the Jefferson Medical College, Philadelphia, on Friday evening, March 4, on "Medical and Other Conditions in Soviet Russia."

THE Minnesota chapter of Sigma Xi recently sponsored the following series of lectures on "Evolution and Civilization": "Critical Epochs in Plant Evolution," Dean E. M. Freeman; "Physical Development of Man," Dean R. E. Scammon; "Primitive Men and Their Cultures," Professor A. E. Jenks, and "Evolution and Life Values," Professor David F. Swenson. The lectures were held in the Northrop Memorial Auditorium on the campus and were open to the public. The attendance was as large as forty-five hundred.

DURING the week of February 8, Dr. Carroll Lane Fenton gave four illustrated lectures before the Department of Geology at the Massachusetts Institute of Technology. His subjects were: "The Environment and its Records"; "Animal Associations of the Sea," "Natural History of Fossils" and "Theories and Records of Evolution."

AT the University of Glasgow, Sir Arthur Keith delivered the Fraser Lecture in anthropology on March 4.

THE American Association of Pathologists and Bacteriologists will meet in Philadelphia from April 28 to 29, instead of from March 24 to 25.

THE Seventeenth Congress of the German Dermatological Society will be held in Vienna from May 16 to 18, when the principal subject for discussion will be cancer of the skin, introduced by Lubarsch of Berlin and Miescher of Zürich.

AN Associated Press dispatch reports that preservation of approximately 6,000 acres of redwood forests in northern California has been made possible by a gift of $500,000 by Mr. Edward S. Harkness, of New York. The contribution has been matched in part by funds from the California State Park Commission and a deed to the forest lands has been acquired by the commission.

THE enlargement of the Bandelier National Monument in New Mexico to approximately 30,000 acres, to give additional protection to its unique prehistoric Indian ruins, and the transfer of jurisdiction over the area from the Forest Service to the National Park Service by presidential proclamation was recently announced.

DISCUSSION

DIRECT FINANCING FOR BASIC SCIENTIFIC RESEARCH

IT is a familiar lament that no part of the financial profit returns directly to science in many cases where scientific research results in applications of great monetary value. Professional tradition forbids the scientist to patent his findings for personal gain, and scientists as a group have been slow to take financial advantage of new knowledge that might be used in support of investigation. There are, however, signs of a changing attitude. In recent years there have been a number of cases in which patents have been taken by individuals or institutions either to protect the public from extortion, in a medical product like insulin, or to secure funds for future investigation. A number of universities derive revenue for research from such royalties, and a corporation has been organized by American psychologists with this as one of its major purposes. The dictum that a scientific laboratory might "live by its findings" appeals to many as sound. If the initial findings were of sufficient practical value a laboratory might even become endowed by a single discovery.

The latest conspicuous example of this movement on the part of American scientists is the current financing of the Basic Science Research Laboratory of the University of Cincinnati. As first conceived by President Schneider, who was then dean of Engineering, this laboratory was to be a cooperative undertaking designed for a physico-chemical approach to biological problems by individuals trained in different fields. It was further hoped that results of commercial value might be obtained and thus financial independence be secured. As the annual budget that could be provided by the school of engineering was a modest one, it was necessary at the outset to undertake certain "commercial" research, and as there was no other housing available the work began literally in a garret. But those who visited that garret in its early years were impressed and not so greatly surprised when the youthful enthusiasm and the downright ability of its investigators brought forth results of scientific importance and commercial value.

With President Schneider as the presiding genius, who conceived the plan and gave it backing in the face of discouragement, and with Professor Sperti as the leader in the laboratory, results have been obtained that have exceeded expectations. The group of investigators that is being developed at Cincinnati can now proceed with adequate financial support of their own making and may hope that other facets of commercial as well as theoretical importance will

be discovered in the future. If once established on a sufficient scale, such a laboratory could maintain not only workers in pure science but also individuals with a sense for the profitable utilization of scientific findings in ways that would probably be overlooked by the investigators themselves.

Briefly, the findings at Cincinnati aside from their theoretical importance have such commercial possibilities that the patents granted have been sold for an amount sufficient to build a laboratory and operate it for several years, while the royalties expected in addition to this fixed payment should be sufficient for the indefinite operation of the undertaking. After a study of the practices in other institutions that support investigation by such means a plan was devised that merits consideration by any university so fortunate as to command revenues of this nature. The essentials of this plan include:

(1) Payment of a cash sum to the university. This money will be used in various ways to further basic research.

(2) Formation of a holding company in which the corporation that has contracted for the patents owns a majority of the stock but the University of Cincinnati a good minority. The university has two members on the board of directors of this holding company, and the corporation involved has three members.

(3) Agreement that the name of the university can not be used in advertising, except with the consent of both university members of the board in each case; that the university will not be involved in the commercial part of the work, except as it is represented on the board of the holding company by the two members; that all developmental research shall be done by the holding company; and that the university shall retain all rights as to medical discoveries and shall derive no financial profit from such discoveries.

(4) There are a number of other provisions, including the control of advertising, stock sales, licensing, etc., all with a view to protection of the public as well as the good name of the university.

Under this form of organization the royalties are received by the university as dividends on its stock in the holding company. The patents are taken out by the workers in the laboratory, and then turned over to the university with the proviso that all the receipts go into scientific research, until this part of the university's function is adequately met. Any remaining funds may go to the general funds of the university, after certain other needs related to research have been provided.

Foremost among the studies that have resulted in this financial provision for future research is the work of Professor Sperti and his associates in the field of ultra-violet radiations. Germicidal and other effects of these rays occur, in many instances if not universally, at critical wave-lengths. It is possible by means of filters to use the radiations for one effect and to block out another effect if the critical points are not too close together. For example, an enzyme had been developed for use in bread-making. As commercially prepared, it produced a bread that decomposed within a short time after baking because moulds and bacteria found their way into the enzyme mixture as manufactured. To have sterilized by heat would have destroyed the enzyme, and to introduce an antiseptic strong enough to be effective was impossible in a product destined for food. The findings at Cincinnati had shown that many enzymes were inactivated at a critical wave-length far enough removed from the wave-length at which bacteria were destroyed so that proper filtration gave destruction of the bacteria without injury to the enzyme. The mixture as thus sterilized produces large loaves of fine texture which can be kept in good condition for long periods. There are so many other applications that one of the largest corporations in the country has become a party to the agreement described in preceding paragraphs of this article. By this means the laboratory in which these facts were established should obtain funds for its continued and independent existence.

If an increasing number of research laboratories can thus be established and "live by their findings," such a development will be one of social as well as scientific importance. Great corporations maintain research laboratories, because in the long run both laboratory and corporation live by new discoveries or by more precise applications of old ones as determined by research. In the situation proposed, workers in pure science would themselves develop industrial applications in order that basic research might obtain adequate financial support and thus live by its findings. If self-maintaining relationships like the one just initiated at the University of Cincinnati could be widely established under the control of scientists, the method would be superior to the existing condition by which basic research is supported inadequately and in haphazard fashion through private philanthropy or as a "noble charity" by industrial organizations.

W. C. CURTIS

UNIVERSITY OF MISSOURI

THE SUPERVISION OF STUDENT RESEARCH

THE practice of having the student who is engaged in experimental research submit weekly written reports of progress has so many advantages that one wonders why it has not come into more general use. Because research is usually costly, there exists the

pernicious, and false, idea that it must be inefficient *per se* and that an almost wanton extravagance in the use of time and of materials may be justified, or even necessary, for the accomplishment of results. There are many who know, however, that it is quite possible to teach the beginner in research how to be economical with his time and materials and how to work systematically and speedily toward definite objectives, so that he may obtain, in the most efficient manner, the best results that his abilities will permit. By this, I do not mean to imply that research can be reduced entirely to formulas, any more than can any other kind of creative work.

It is my experience that the written progress-report, when used as a complement to the personal conference, is a most effective means of promoting such efficiency. The student must of course be made to see very clearly that these reports are only a means toward an end in his research and that they are not, for example, intended to be a check on the number of hours that he spends each week on his work. Their purpose is to encourage systematic planning of work and frequent estimates of progress and to afford the student the opportunity of laying his case, so to speak, before the director of his research at least once every week. There is a great advantage in having the student begin to make his reports as soon as he has selected his problem; these initial reports, which must necessarily deal mostly with the preparatory reading, provide definite objectives toward which he can work from the very start, something which the beginner often lacks in the early stages of his problem.

The form of report that follows has proved itself suitable for experimental physics; the numerals in parentheses indicate the number of blank spaces allowed for each item:

Weekly Report of Research Progress

Name ..... Date .....

General problem: .....

1. Particular work in which now engaged: (4)
2. Progress during the past week: (8)
3. Specific difficulties encountered: (10)
4. Approximate date of completion of this particular work: (2)
5. Next specific project probably to be undertaken: (6)
6. Unavailable apparatus and supplies needed for this new work: (8)
7. Bibliography of the week,
   (a) Publications found: (8)
   (b) Publications read: (Use reverse side for titles and for points involved in these papers which need discussion in conference.)

The reasons for including these various items in the report are too obvious to require much comment. The fifth item is perhaps the most important of all. The usefulness of the sixth will be apparent to any one who has experienced the aggravating delay involved in obtaining equipment that is not already in stock. The last two items serve as weekly reminders to the student to be constantly on the watch for new papers having a bearing on his problem and to read continually. In this connection, it is worthy of remark that a certain foreign-trained physicist whose opinion is to be respected and who has a high regard for the state of experimental physics in this country deplores the waste of time and money which results from the failure of many American-trained physicists to study thoroughly the literature dealing with their problems.

It must be emphasized that these written reports are not intended to supplant the personal conferences which the supervisor must have with his students. In a sense, they are to be regarded as a preparation for the conferences. Through the medium of the report the supervisor has advance knowledge of the specific difficulties confronting the student, and it sometimes happens that the student himself will arrive at a solution of these difficulties, simply because the written report has forced him to define and clarify them.

If there is a single disadvantage in using such a system of reports it has not yet become apparent. Seven students are at present using this method under my direction; four of them are graduate students working independently, two are graduate students working as apprentices to more experienced students, and one is an undergraduate. All of them have reacted favorably to the plan and have recognized its advantages. The research supervisor who has not as yet used this or a similar method would do well to consider it, especially if he is attempting to direct the research of several students while engaged in other teaching and in his own research.

DUANE ROLLER

DEPARTMENT OF PHYSICS,
UNIVERSITY OF OKLAHOMA

VITAMIN A AND THE IODIN-FAT BALANCE[1]

So many papers have been published within the past two years regarding the rôle of carotene as a precursor of Vitamin A that it may not be out of place to call attention to the fact that carotene is a highly unsaturated hydrocarbon ($C_{40}H_{56}$), and that it is commonly administered in combination with arachis (peanut) oil which has an iodin value ranging from 83.0 to 100.0 and which contains the unsaturated linoleic and oleic acids, together with several of the saturated acids. While the manner in which carotene may behave has not been clearly demonstrated, it is the belief of the writer that its significance in

[1] From the Laboratories of West Virginia University, Morgantown, West Virginia. Aided by a grant from the National Research Council.

he formation of Vitamin A in the animal depends in rge part upon:

(a) The rôle of the unsaturated hydrocarbon caroene and the associated fatty acids found in arachis il in restoring the fat-iodin balance in animals, fat epleted by Vitamin A deficiency diet.

(b) Its action in restoring the desaturating power f the liver.

From a series of studies with ferrous iodide carried n since 1925 we have come to the conclusion that here are two factors in recovery from Vitamin A eficiency, one, effective in curing *xerophthalmia*, and *itis media*, and in awakening the dormant thyroid; he other belonging to unsaturated fats and hydrocarons, aiding to restore the iodin-fat balance and acilitating growth.

As reported at the Cleveland meetings of the merican Association for the Advancement of Science (1930) we find that linoleic acid is extremely effecive when combined with the ferrous iodide. Studies uring the past winter and now in progress indicate hat ferrous iodide and linoleic acid will act more favorably on rats, profoundly depleted of Vitamin A, than cod liver oil.

That ferrous iodide alone should prove beneficial n Vitamin A deficiency, accompanied by certain ymptoms of thyroid disturbance is probably due to he iodin action on keratinized tissues and the withdrawal of stored fats from the animal. The dormant hyroids of animals that have received a fat-free diet or some time are apparently stimulated by the ferous iodide, and the addition of unsaturated fats ids in restoring the balance. Further details regarding the experiments now in progress will be published soon, with the names of our laboratory assistants (Chidester, Bourne and Wiles).

For a long time it has been known that while Vitamin E is essential for reproduction, it is no more so than Vitamin A. Evans and Burr (1925) have stressed the fact that Vitamin E is concentrated in the seeds and embryos of certain plants as well as in egg yolk. The fact that in experimental studies that we are now carrying on, we have noted gonadal development in animals thoroughly depleted of Vitamin A and then furnished linoleic acid and extremely small quantities of ferrous iodide is, we believe, rather significant. Schmidt (1891) and also Miller (1910) and Ivanow (1912) have shown that the *iodin* numbers of the *unsaturated acids* and oils of various seeds decrease during germination. Numerous investigators have demonstrated that either an excess of iodin or an excess of fat will induce sterility in experimental animals. We contend that iodin-fat imbalance is a most fundamental one in deficiencies in fat soluble Vitamins A and E.

F. E. CHIDESTER

THE FEEDING HABITS OF THE FIRST INSTAR LARVAE OF THE CLUSTER FLY

FIRST instar larvae of the cluster fly, *Pollenia rudis* (Fab.), have been observed in the laboratory feeding upon the earthworm *Allolobophora caliginosa* (Sav.). Former records indicate only *Allolobophora chlorotica* (Sav.) and *Eisenia rosea* (Sav.) as hosts to this parasite.

Former investigators have not observed the entrance of the first instar larvae into the body of the earthworm. Keilin (1915) suggested that the larvae probably enter by means of the genital pores while the worms are in copula.

First instar larvae have now been observed by the author to enter directly through the cuticula. They have been observed in various stages of entrance, from the time when only the mouth parts were imbedded in the cuticula until only the posterior spiracles were exposed. First instar larvae apparently always feed with the spiracles exposed.

As many as five larvae have been observed feeding on one worm. They usually enter the anterior portion of the worm in the region from the tenth segment to a few segments posterior to the clitellum. All the larvae so far observed have entered the worm from the dorsal side. While the usual place of entrance seems to be the intersegmental furrows, the larvae have been observed entering through the thicker portions of a segment and also through the clitellum.

The earthworms were placed in a petri dish containing usually about thirty eggs of the dipterous parasite. The worms were introduced as the larvae began to emerge from the eggs. Parasitism usually occurred about two days later.

Mrs. Grace Pickford Hutchinson, of Osborn Zoological Laboratory, Yale University, very kindly identified the earthworms as *A. caliginosa* (Sav.).

R. M. DECOURSEY

DEPARTMENT OF ZOOLOGY,
CONNECTICUT AGRICULTURAL COLLEGE

BRANCHINECTA COLORADENSIS IN COLORADO

IN the February 27 and September 11, 1931, issues of SCIENCE there was a discussion as to means of dispersal of the fairy shrimp, *Branchinecta coloradensis*. In the latter article it is also recorded from a hollow in a boulder at the elevation of 8,000 feet near Estes Park. In Ward and Whipple it is recorded as an alpine species. Dodds, in his "A Key to the Entomostraca of Colorado," gives its distribution as alpine, but with one record from St. Vrain at an elevation of 5,100 feet.

My own experience shows that it is not nearly so strictly alpine as has been supposed. I have collected

it from small hollows in granite outcroppings on Arthur's Rock, west of Fort Collins, and overlooking the plains, elevation about 6,800 feet; about four miles east of Allen's Park, elevation about 8,300 feet; and on Old Man Mountain, just west of Estes Park village, elevation 8,300 feet. In these little hollows it was often quite abundant, but smaller than individuals from the alpine ponds. This might well have been due to the lack of food in these temporary puddles. I have also found it in the ponds of the thick timber around the 10,000 feet levels.

I have assumed in the past that wind was a considerable factor in distribution. The eggs undergo desiccation and might then be carried by the wind. The hollows were on exposed outcrops. The winds of the winter half of the year are often quite strong, and prevailingly from the west or northwest, so that the eggs could conceivably be carried out over the middle and lower mountains, and dropped in the small hollows which are characteristic features of the rock ridges and outcrops.

KENNETH GORDON

UNIVERSITY CAMP,
UNIVERSITY OF COLORADO

A TEMPORARY RESPITE FOR THE WHALE

THE past season's whaling operations resulted in a killing orgy, chiefly in the Antarctic, that broke all records. The world catch, of late increasing from season to season, amounted last year to 38,563 whales, which yielded more than 3,427,000 barrels of oil. The supply so far exceeded all ordinary demands that whaling vessels were laid up and much oil stored. Present-day whaling is largely a Norwegian industry, about which there is not much general knowledge in this country. Naturalists concerned about the supply of whales have been wondering what the next move of the industry, with its huge investment in specially built steamships, would be.

Information received last week from a Norwegian friend in Tonsberg, who knows what is going on, throws light on the subject:

> . . . So far as I can gather, the outlook is this: Next season only the modern vessels will go out, and that only provided they have been able to sell the oil in advance. There is still a quantity of say 500,000 barrels unsold of last season's catch. . . . Sandefjord, Tonsberg and Larvik are the New Bedford, New London and Nantucket of Norway at the present day, with Sandefjord leading. I visited that place the other day, and I must confess that the harbour was a truly magnificent sight; whale catchers in long rows, one alongside the other, and the huge factory ships completing the picture. Some 8,000 men are idle at home this year. . . .

My correspondent adds that only two fleets, those of Leith and Liverpool, comprising four factory steamers with their complete sets of whale catchers, have been sent out. Early last summer I boarded one of the big Antarctic whalers, unloading her oil —55,000 barrels—at Staten Island. She had taken 1,445 whales.

The species chiefly pursued in Antarctic waters are blue whale and finback, which did not figure in the catch of the old time whaler. His methods were less effective. Other kinds of whales, such as sperm, right, humpback and sei, are no longer abundant. These were greatly reduced in numbers during the nineteenth century. The grey whale has become a rarity and the once important bowhead does not figure in modern whaling at all.

There is a year's supply of whale oil on hand. Whaling ventures as a whole are in abeyance until next fall. It is evident that the stock of whales has greatly decreased. It would be deplorable if the last season's slaughter were repeated in 1933, and the world's most important animal-oil resource seriously damaged.

C. H. TOWNSEND

NEW YORK AQUARIUM,
FEBRUARY 13, 1932

EPIZOOTIOLOGY

THESE pages frequently serve as a hospital for sick words. May I therefore bespeak a bed for "epizootiology," whose usefulness appears to have passed and who may well be relieved by the more vigorous word "epidemiology"?

I am acquainted with some learned men who think it an outrage to apply this most valuable word to the spread of disease among animals, men to whom presumably the epidemiology of anthrax conveys a totally different idea from the epizootiology of that disease, but who may be puzzled to find any word for a spreading disease among insects. Surely the idea which is carried by the word "epidemic" centers on disease, and "the spread of disease" as a separate idea does not fundamentally concern the association of that disease with plants, men, animals, land, sea, Europe or America.

Where words are concerned the purists lose in the end; and in spite of what may be said to the contrary common use is often common sense. Valuable new words grow into definite meanings of their own and forget their origins, while bad words die. There can be little doubt that "epidemic" is growing into the recognized English word for disease spreading amongst any community.

A recent correspondent of SCIENCE writes that "the English language would be in better shape if some

people knew less Greek and Latin," and I suggest that, if the epidemiologists will leave their experimental animals for a few moments we might take "epizootiology" from the sick bed to the lethal chamber. Their studies could then be resumed in peace, free from the disturbing thought that much of their epidemiological research is in reality epizootiology.

VETERINARY LABORATORY, E. L. TAYLOR
MINISTRY OF AGRICULTURE AND FISHERIES,
WEYBRIDGE, SURREY

SPECIAL CORRESPONDENCE

EUROPEAN EXCURSIONS IN 1932

Two cooperative excursions through Europe are being organized for the summer of 1932, the programs of which present some unusually attractive features and the costs of which will be moderate. While intended primarily for entomologists attending the Fifth International Congress of Entomology at Paris in July, and for their families and friends, other scientific men, up to certain limits, will be welcome.

The first group will sail from New York on the *Leviathan* on June 11, visiting (among other places) Copenhagen, the Gota Canal in Sweden, which will be partly traversed on midsummer night when all the village folk hold festival and dance all night in the open air; Stockholm, Uppsala, the summer home of Linnaeus at Hammarby, and thence by rail northward to the Swedish National Park in Lapland, where a stay of some days will be made on the Arctic tundra at Abisko with views of the midnight sun. Those who wish will have time to continue by excursion steamer to the North Cape and back. Returning to the Continent, some days will be spent in Holland and Belgium before going to Paris for the congress. After that event there will be a week's excursion in the Pyrenees, arranged by the French local committee of the congress. Then Avignon will be visited, with an excursion to Orange and the home of Fabre at Serignan. Continuing to Grenoble, the party will traverse the Savoyan Alps by motor coach to Argentières at the foot of Mount Blanc, and after some days will continue by motor coach to St. Jeanne de Maurienne, and thence into Italy, where Turin, Genoa, Pisa, Naples, Rome, Assissi, Perugia, Florence, Bologna and Venice will each be visited. Continuing over the Brenner Pass, a short stay will be made on the Eibsee in the Bavarian Alps, with opportunity to ascend the Zugspitze, Germany's highest peak. Munich, and the three beautifully preserved medieval cities, Dinkelsbühl, Rothenburg and Nuremburg, will be visited, also Leipzig during the autumn fair, Dresden, the Spreewald and Berlin. After a final few days in England the party will sail for home on September 17 from Southampton.

The second group will sail from New York on the *Olympic* on July 1, joining the first group in Holland and remaining with them until the Alps are reached. They will omit Italy, and make a somewhat swifter tour of Germany, with also a few days in England before sailing on August 27, on the luxurious new liner *Manhattan*. Those wishing to go directly to the congress will sail on the *Majestic* on July 8.

These are not conducted tours in the usual sense, but are organized for pecuniary benefit of individuals comprising a group. Members will be free to follow their own inclinations at the stopping places, and in the larger cities in most cases may take their meals at restaurants of their own choosing. While many of the points to be visited were selected because of their importance as entomological centers, all will be full of interest from other points of view.

Estimates are based upon tourist class (former second class) at sea, second-class railway, unpretentious but thoroughly comfortable and clean hotels and inexpensive restaurants, with an allowance for side-trips and for incidental and personal expenses. They have been kept as low as possible, consistent with comfort, in order to make the trips available for students of limited means, who may look upon them as part of their educational equipment.

Readers of this notice, who may be going to Europe, even though not as members of one of the groups, are welcome to share in certain advantageous arrangements which the committee has been able to make, provided they request the committee to obtain their steamship reservations for them.

For complete circulars and information address the undersigned, who is chairman of the Joint Committee of the Entomological Society of America and Association of Economic Entomologists on Transportation to Europe.

O. A. JOHANNSEN

ROBERTS HALL,
ITHACA, N. Y.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A MICROSCOPE FOR OBSERVATION OF FLUORESCENCE IN LIVING TISSUES

FLUORESCENCE, the phenomenon which makes possible the technique described below, has been utilized in microscopic work, but principally in relation to the study of inanimate organic compounds. It may be defined as the property possessed by certain substances to generate light which is different in color

from the light thrown upon them. For example, in the path of invisible ultra-violet rays, aesculine has a brilliant blue fluorescence. There is a twofold specificity in the property, first in the length of the wave to which the substance will respond, and, second, in the color of the induced light. The fluorescence microscope has made use of this specificity to identify substances which are similar morphologically but different chemically (Lehmann, '13, Wasicky, '14, Heller, '16, Merritt, '26).[1] The study has been applied to the animal body, and fluorescence has been found to be of general occurrence, but it is very slight except in the case of certain special tissues, the lens of the eye, for example.

For this reason the characteristic, inherent fluorescences of the individual tissues could not be made the basis for observation of the living animal. Instead, a highly fluorescent and non-toxic solution, such as uranine or aesculine, was injected into the animal and as it was taken up by the blood plasma, it transformed the latter into what may be pictured as a circulating source of light. The different elements of the tissues were brought into visibility by their varying degrees of opacity to the induced light or their power to refract it, by their opacity to the incident light or by absorption of the fluorescent substance itself.

Although the ordinary fluorescence microscope employs transmitted light, this type of illumination had to be abandoned in observation of the organs or tissues of the intact animal (frog, rat, mouse, etc.) because of their opacity. Oblique illumination sufficed for primary magnifications up to 30 diameters, but for higher magnification vertical illumination was used. In the latter case, the rays of light were reflected through the objective by means of a vertical illuminator similar to the instrument used in metallurgical investigations (Fig. 1). In order to obtain a uniform illumination of the object, it was necessary to have the back lens of the objective as near to the glass plate reflector as possible (Fig. 1 D). The magnifications obtained varied from 300 to 1,200 diameters. The focusing collar (manufactured by the Bausch and Lomb Company) illustrated in Fig. 1 G, was designed to accomplish two things: (1) to hold the object at the proper place of focus, and (2) to permit the surface of the lens to be washed

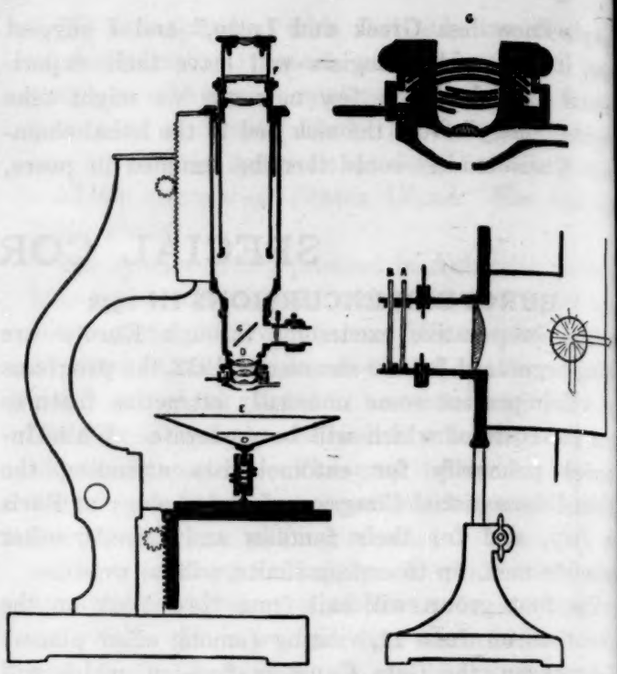

FIG. 1. The microscope and the illumination apparatus. (A) Heat-absorbing filter; (B) main absorbing filter; (C) planoparallel slide of the vertical illuminator; (D) lens with focusing apparatus; (E) adjustable operating board and mechanical stage; (F) eyepiece with complementary absorbing filter; (G) lens with focusing apparatus, original size.

free of blood and débris by a perfusing fluid such as physiological salt solution. Without this device, continuous observation was almost impossible.

The therapeutic sunshine carbon arc of the National Carbon Company was usually employed as a source of light, although any light source rich in ultra-violet, such as an iron, carbon or mercury arc, proved satisfactory. The band of spectrum reflected by the planoparallel glass slide of the vertical illuminator was controlled by selective filters. The injurious infra-red rays were eliminated by 3 mm of heat-absorbing glass (Fig. 1 A). Although this filter allowed but 64 per cent. of the radiant energy from the arc to pass, it did not make an appreciable reduction in the brightness of the light.

The main absorbing filter (Fig. 1 B) was varied to select the band of spectrum most effective for the fluorescent compound in use. The optimum conditions were obtained when rays which were not effective in inducing fluorescence were eliminated because the reflection of diffuse light by the tissues interfered with visibility. With aesculine, the Red Purple Ultra (Corning Glass Works) was used. It transmitted 365 μ ultraviolet, 405 μ violet and 435 μ blue as well as extreme red, but the latter was unimportant since it had already been eliminated by the heat filter.

It was not always possible to obtain the exact combination of wave-lengths required for a particular

[1] R. Heller, "Fluorescence of Alkaloids and Its Application in Toxicological Investigation," *Intern. Zeitsch. phys. Chem. and Biol.*, Vol. 2, pp. 297–411; *Intern. Chemical Soc.*, Vol. 110, ii, p. 502, 1916; Lehmann, "Luminescence Microscope," *Ztschr. f. wiss. Mikr.*, Vol. 30, p. 449, 1913; Merritt, "The Form of the Absorption Bands in Solutions of Organic Dyes and a Relation between Absorption and Fluorescence," *Phys. Rev.*, Vol. 28, pp. 684–94, 1926; R. Wasicky, "The Fluorescence Microscope in Pharmacognosy," *Pharm. Post* (Vienna), Vol. 46, pp. 877–8, 1914.

fluorescent substance by means of the main filter alone. When this was the case, the desired bands were added by the introduction of a supplementary light source and appropriate filters (Fig. 2_4).

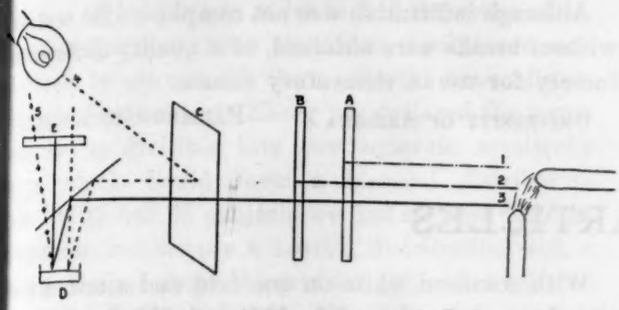

Fig. 2. The path of the rays. (1) Infra-red rays; (2) visible rays; (3) ultra-violet rays; (4) rays of the supplementary illumination; (5) fluorescent rays. (A) Heat-absorbing filter; (B) main absorbing filter; (C) reflector (Corex D Glass 2.10 mm thick); (D) tissue and fluorescence fluid; (E) complementary absorbing filter.

In order to make the outlines of the objects clearer, a complementary absorbing filter was inserted in the tube of the microscope between the eyepiece and the vertical illuminator. Different filters were required for different colored fluorescent light. With aesculine, which gives a blue light, a green filter (Nultra, Corning Glass Works) was used. Green required a yellow complementary filter, while violet fluorescence required none.

The important and difficult part of the technique deals with the light source and lens equipment. The procedure for making observations can be given briefly. Aesculine will be given as an example because it gives a brilliant fluorescence. The experimental animal (frogs, rats and mice have been used) was anesthetized and fixed to the adjustable operating board (Flg. 1 E). After the desired tissue or organ was exposed, it was brought into focus with ordinary white light. A concentrated aqueous solution of the fluorescent substance was injected subcutaneously. The filters (Figs. 1 A and B) were inserted and observation made through the microscope until fluorescence appeared.

This technique not only gives us a new application of a method (Thiel, '26, Ellinger and Hirt, '29)[2] for observing the interior of the living organism, a subject of interest in itself, but it has opened up a new experimental approach to other problems. It has given some unexpected information concerning the penetration of the layers of the skin by different wave-lengths of light. The excretion of aesculine by the liver and kidney causes the bile capillaries and uriniferous tubules to become brilliantly illuminated, and this is being used as the basis for physiological studies of these organs.

Edward Singer

Columbia University

[2] Thiel, "Contribution to the Slit Lamp Microscopy of the Eye in Ultra-violet Light," *Ztschr. f. Augenheilk.*, Vol. 58, p. 56, 1926; Ellinger and Hirt, "Microscopical Observation on Living Organs," *Zschr. f. Anat. u. Entw.*, Abt. i, 90: 791–802, 1929.

AN IMPROVED PROSPECTING PICK

Geologists and fossil collectors have long felt the need of an accurately adjusted light prospecting pick, but heretofore only hand-made tools of this description have been obtainable.

After years of experience the American Museum of Natural History has developed what is considered a perfect tool of the kind, of drop-forged highest grade 85 carbon tool steel, with a perfect eye extended so as to secure the full purchase power of the

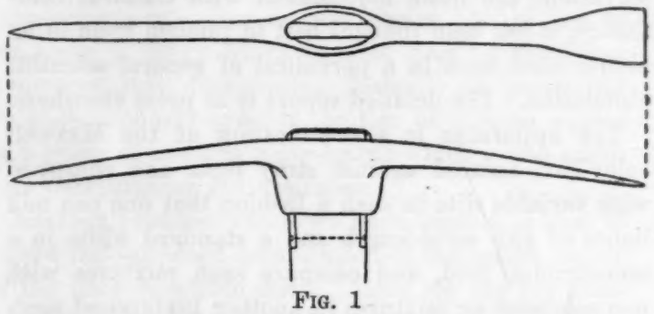

Fig. 1

handle. A metal bar inset over the head of the handle and riveted insures a perfect fit during the life of the tool regardless of shrinkage or number of times the pick is removed from the handle. Length of metal head fifteen inches, length of handle twenty-one and one half inches, total weight one pound and ten ounces.

These picks can be obtained from the Department of Vertebrate Paleontology, American Museum of Natural History, New York City.

Barnum Brown

January 26, 1932

A QUICK METHOD OF EMBEDDING SOFT MATERIAL IN CELLOIDIN

At the suggestion of Dr. A. F. Hemenway some experiments were made with celloidin dissolved in acetone for embedding green material that requires no softening. The blocks of material were prepared for cutting in three days by ordinary laboratory methods. Under reduced pressure leaf and soft stem material of *Hedera helix* and *Olea europea* were prepared in 50 minutes from the time the fresh material was gathered until the sections were mounted in balsam on the slides. There was little or no plasmolysis, no alteration of the natural color of the material, but it was necessary to bleach with 95 per cent. alcohol when staining was desired.

Schedule:

Cut material so that vascular tissue is not more than ¼ inch long.

Under reduced pressure, place in killing solution consisting of formalin, 6.5 cc; 50 per cent. alcohol, 100 cc; glacial acetic acid, 3 cc; glycerin, 5 cc.

Leave in killing solution five minutes.

Put through two changes of water, two minutes each.

Flood with acetone for five minutes, then for five minutes each in the following percentages of celloidin and acetone: 3 per cent., 7 per cent., 10 per cent., and 14 per cent.

Place specimen on wood block with a thin covering of very thick celloidin. Let it become firm in air, then drop into chloroform until solid enough to cut.

Although infiltration was not complete, 12m sections without breaks were obtained, of a quality quite satisfactory for use in elementary classes.

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SPECIAL ARTICLES

TRICHROMATIC FUNCTIONS OF THE AVERAGE EYE[1]

THE trichromatic color mixture curves have been studied on 68 subjects. Inasmuch as certain of the observations are quite inconsistent with classical color theory, it has been thought best to publish them in an abbreviated form in a periodical of general scientific circulation. The detailed report is in press elsewhere.

The apparatus is a modification of the Maxwell color-box, secured against stray light and equipped with variable slits in such a fashion that one can mix lights of any wave-length and a standard white in a semicircular field, and compare such mixtures with monochromes or mixtures in another juxtaposed similar field. The total field size was 1° 40′.

The source was two 500 watt tungsten lights operated at 2790° K diffused by three double ground sheets of optical glass (Eastman).

With standard white on one field and a mixture of the three primaries, 480, 517 and 670 mμ, on the other, each of the 68 subjects was asked to glance at the field (with centered pupil) and say how the appearance differed from a perfect match. In the light of his answer the color mixture was changed until the subject stated, after looking with each eye rested, that he could see no difference between the fields.

Dichromatic matches to monochromes were made in the same fashion.

The average amounts of the primaries required to match white are red 1.740 mm of slit-width; green 1.441 mm, and blue 1.249 mm after adjustments had been made for green excitation in 480 mμ. Instead of recalculating our data to conform to assumptions of equality of chromatic valence of the three primaries, any other match is presented and plotted directly as the slit-width of each primary required for a white or found.

(1) This investigation had for its first aim the de-

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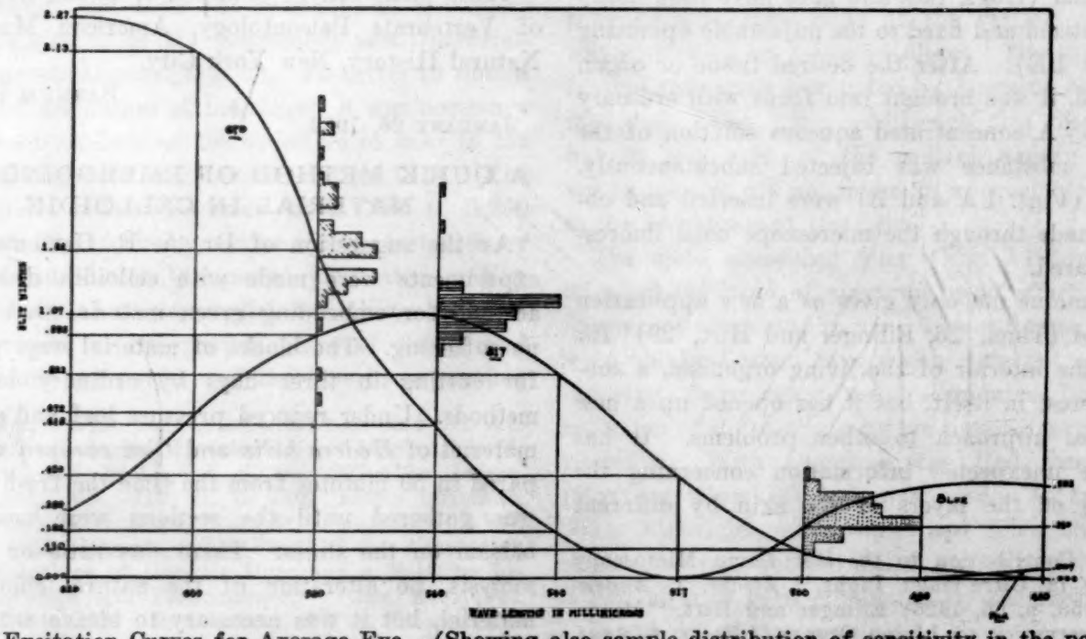

FIG. 1. Excitation Curves for Average Eye. (Showing also sample distribution of sensitivity in the population: diagonal is red; horizontal is green; stippled is blue.

rmination of the sensitivity of the average eye to h of the three primaries. Normal individuals dif- widely in these respects. Yet each investigator s hitherto offered results for an inadequate number subjects. We have, therefore, determined the sen- ivity of 68 subjects in order to find the range of in- idual differences, their statistical significance, and tatively to account for them. On the basis of data om only four subjects König has declared the popu- ion to be divisible into two separate sensitivity oups which would form a bimodal distribution rve. With our 68 subjects we find no such bimodal gregation, but simply a normal distribution with a tinct massing about the median. We have selected pical distributions for the primaries and blocked em in Fig. 1. We have shown for the match to 580 the distribution of the red component only (diag- al lines); for the match to 560 mμ the distribution the green component only (horizontal lines); and r the match to 500 mμ the blue component only tippled). These three are typical of the distribu- on of sensitivity for each component in all the atches, and illustrate the normal distribution of sen- ivity in the population.

The cause of differences in sensitivity to the pri- aries has generally been attributed to varying nounts of macular pigment from subject to subject. this were true, variations in matches should have en greatest in the yellow-blue direction. We, how- ver, found variations to be greatest in the red-green irection. This circumstance, together with other levant facts, obliges us to suppose that macular pig- ent is at most a secondary cause of variation, and at the fundamental cause is a genuine difference in e sensitivity of physiological function of the re- ptors themselves.

The three curves are a plot simply of the average nsitivity of the 68 observers for each match, and pply data which are of value in discussing the chro- atic functions of the average eye, and in establish- g colorimetric standards.

(2) The second aim of our investigation was to de- rmine where the loss of saturation of mixtures be- ins, why it occurs and particularly to establish the recise conditions under which it occurs.

All previous workers have reported this desatura- on for the mixtures which match an extensive region of the spectrum, and have gone so far in assuming it to be a universal quality of color vision under all conditions as to think it unnecessary to describe the experimental situation under which it has been ob- rved. We also find a loss of chroma, but for a very stricted region of the spectrum. Why this differ- nce? They have worked under artificial conditions. hese do not simulate the situation in ordinary useful vision which involves an adaptation of the retina to an intensity similar to the intensity of the photometric field. They have employed dark-adaptation and so have unwittingly admitted scotopic factors which cause a desaturation of the field containing the short- est wave-lengths. This is, of course, the mixed field. As our work, on the contrary, was done under light- adaptation, this scotopic desaturation was escaped, and the conditions of ordinary useful vision were re- produced.

But loss of saturation may also be due to an "im- pure" green primary; that is, one of such short wave- length as to stimulate the blue sensory apparatus as well as the green. Such a desaturation is introduced, again unwittingly, because the choice of primaries is fallaciously assumed to be indifferent since, as it is thought, results based upon different sets of pri- maries may be equated by means of suitable algebraic transformations. Our careful choice of 517 mμ as the green primary which is most nearly "pure" has eliminated this desaturating factor. By using 517 we have similarly avoided the loss of chroma caused by a green of too long wave-length which would intro- duce desaturating red excitation.

Another problem which we have treated is how to regard the supposed desaturation of the yellow region of the pure spectrum itself. Here we are not deal- ing with a loss of chroma due to a mixing of stimuli, but with a supposedly inherent desaturation arising from the unmixed yellow itself. As desaturation is held due to the simultaneous stimulation of the sen- sory apparatus for the three primaries, the blue curve is extended far into the long-wave region of the spec- trum, to explain this. We feel that this extension of the blue is merely a postulate which has derived its force from tradition, and that under critical examina- tion it becomes unwarranted. It is difficult to see how a set of curves with the blue primary extending up into the red can be made to harmonize with the color mixture data which we present. Fig. 1 shows that blue does not extend above 517. Why, then, has it been the fashion to extend it? We can account for the extension when we observe that the supposed equal chroma cancelling power of the primaries in produc- ing white is assumed to mean also equal luminosity of the processes elicited by the stimulation of each of the three mechanisms involved in white. But since the blue which is sufficiently intense to cancel yellow chroma is much less luminous than the yellow itself, it is erroneously held, therefore, that yellow contains blue; *i.e.*, is unsaturated in the usual sense. Thus the ascription of an intrinsic blue process in the yellow arises from the illegitimate application of terms rep- resenting chroma cancelling power to situations in- volving luminosity.

We believe that the Gordian knot may be cut by discarding the traditional definition of white, and assuming that red and green, when mixed alone, tend to cancel each other's chroma without the intervention of any blue process whatever. This leaves but little chroma for the blue to cancel when mixed with yellow. Consequently, no intrinsic blue process need be assumed to accompany yellow, and the extension of the blue curve into the yellow region need not be postulated.

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CHEMICAL COMPOSITION OF RICE AND ITS RELATION TO SOIL FERTILITY IN CHINA AND JAPAN

IN 1929 W. F. Gericke[1] offered a new explanation of the fact that oriental countries have been able to maintain a relatively high production of rice without the exhaustion of the soil similar to that caused "by continued cropping of land to cereals of occidental countries if practiced without fertilizers." On the basis of experiments in which rice was grown in nutrient solutions, he comes to the conclusion that the rices of the Asiatic countries have adapted themselves so that normal crops are produced with a low content of minerals, especially calcium, magnesium, phosphorus and sulphur. He does not make clear whether this holds only for orinetal rices or also for rice grown in other countries. If he meant that rice in general has a lower content of the mineral elements than do wheat, barley, etc., it would have been simpler to compare the respective chemical composition of these crops given in the literature instead of referring to his "minima" experiments. It is well known, for instance, that rice contains, as a rule, less nitrogen, phosphorus and potassium (the three essential elements which are generally applied in fertilizers) than do the staple cereals of this country, especially wheat. However, the average yield of rice in America, China, Japan and India is two or three times as high as that of wheat. Accordingly a crop of rice will remove from the soil at least as much plant food as a crop of wheat. The article would seem to indicate, therefore, that according to Dr. Gericke's belief the range of variation of the mineral content of oriental rices is considerably below the corresponding range of those grown on soils not exhausted by continuous cropping or grown with artificial fertilizers.

It seemed to us that a comparative analysis of Chinese and American rices could throw some light on such a hypothesis. We obtained from China samples of rice of five varieties and analyzed them for ash, nitrogen, potassium, phosphorus, calcium and magnesium. We also determined these elements in three samples of rice grown in this country and on a sample grown in Porto Rico. The results, calculated on the air-dried basis, are given in Table I.

CHEMICAL COMPOSITION OF CHINESE AND AMERICAN RICE

		Percentage on Air-dried Basis						
No.	Origin	Ash	N	P_2O_5	K_2O	CaO	MgO	S
1	China	1.22	1.23	0.60	0.259	0.014	0.187	0.0
2	"	1.24	1.26	0.64	0.273	0.020	0.206	0.0
3	"	1.32	1.23	0.65	0.264	0.020	0.208	0.1
4	"	1.39	1.26	0.68	0.293	0.020	0.224	0.0
5	"	1.30	1.23	0.66	0.312	0.019	0.214	0.0
6	United States	1.58	1.44	0.76	0.314	0.025	0.244	0.0
7	" "	1.20	1.46	0.58	0.238	0.022	0.208	0.0
8	" "	1.58	1.46	0.76	0.328	0.020	0.235	0.0
9	Porto Rico	1.24	1.01	0.56	0.306	0.025	0.193	0.0

It is realized that these results are too meager to form a basis for definite conclusions, but these samples, picked at random, do not indicate any striking differences in composition between the Chinese rices grown on a soil presumably cropped for thousands of years, and the rices grown under the American method of cropping.

Moreover, Dr. Gericke's explanation does not take into account nitrogen and potassium, which, with phosphorus, are most frequently the limiting factors in crop production. Calcium, magnesium, sulphur and iron are found in crops in relatively small quantities and are seldom applied as fertilizers. Furthermore, the late Professor F. H. King, in his book "Farmers of Forty Centuries" (quoted by Dr. Gericke), claims that "these people (Chinese and Japanese) are now and probably long have been applying quite as much of these three plant foods (nitrogen, potassium and phosphorus) as are removed by the crop" (p. 190). It is true, then, that rice in China and Japan is grown under continuous cropping but not without restitution of plant food.

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[1] SCIENCE, 70; 1818, pp. 430–432.

BOOKS RECEIVED

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE: *Chemistry at the Centenary (1931) Meeting*. Pp. xi + 272. Illustrated. Heffer, Cambridge. 7/6.

CLARK, AUSTIN. *The Butterflies of the District of Columbia and Vicinity*. Pp. ix + 336. Illustrated. Smithsonian Institution Bulletin 157. U. S. Government Printing Office. $1.50.

SMITH, HOMER W. *Kamongo*. Pp. 167. Viking Press. $2.00.

TOHÔKU IMPERIAL UNIVERSITY. *Science Reports*. Vol. VI, No. 4. Pp. 573–809. Illustrated. Maruzen.

YATES, DOROTHY H. *Psychological Racketeers*. Pp. 22[illegible] Badger. $2.00.